Inventory & Monitoring Program

Pacific Island Network

Monitoring Plan

Supporting Documents: Haleakala National Park Resource Overview

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Pacific Island Network (PACN)

Territory of Guam
War in the Pacific National Historical Park (WAPA)

Commonwealth of the Northern Mariana Islands
American Memorial Park, Saipan (AMME)

Territory of American Samoa
National Park of American Samoa (NPSA)

State of Hawaii
USS Arizona Memorial, Oahu (USAR)
Kalaupapa National Historical Park, Molokai (KALA)
Haleakala National Park, Maui (HALE)
Ala Kahakai National Historic Trail, Hawaii (ALKA)
Puukohola Heiau National Historic Site, Hawaii (PUHE)
Kaloko-Honokohau National Historical Park, Hawaii (KAHO)
Puuhonua o Honaunau National Historical Park, Hawaii (PUHO)
Hawaii Volcanoes National Park, Hawaii (HAVO)

http://science.nature.nps.gov/im/units/pacn/monitoring/plan/

EXECUTIVE SUMMARY & INTRODUCTION

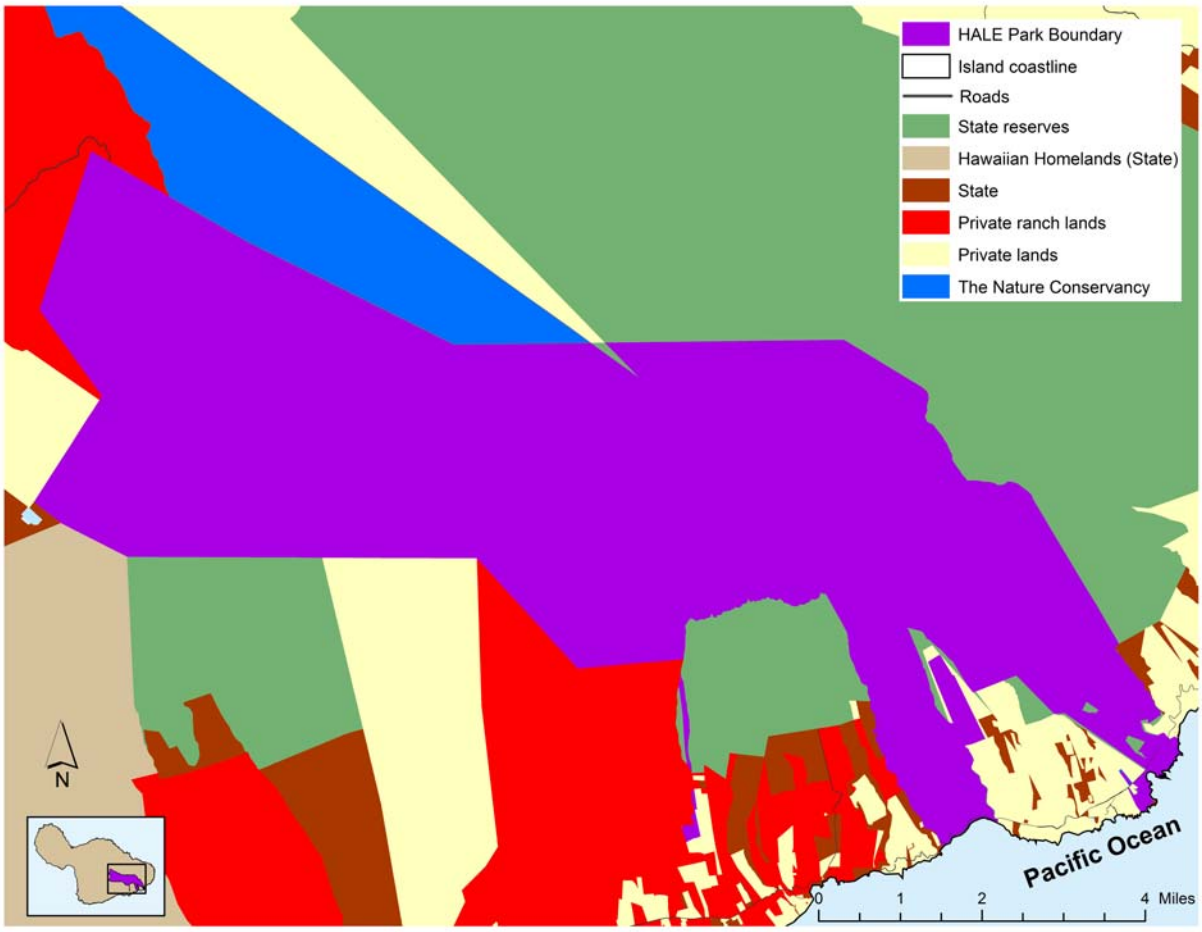
Enabling Legislation

Enabling legislation to establish a national park in the Territory of Hawaii was approved August 1, 1916 (39 Stat. 432). The enabling legislation (16 USC 391) for Hawaii National Park states that it *"...shall be perpetually dedicated and set apart as a public park or pleasuring ground for the benefit and enjoyment of the people of the United States…and provide for the preservation from injury of all timber, birds, mineral deposits and natural curiosities or wonders within said park, and their retention in their natural conditions as nearly as possible.*" Effective July 1, 1961, the Haleakala Section of Hawaii National Park on the island of Maui was established as a separate unit and to be administered in accordance with the NPS Organic Act (39 Stat. 535 and with any other applicable provisions of the law relating to the Maui section of Hawaii National Park (16 USC 396).

To find enabling legislation documents on-line follow the "Policy & Legislation" link from the Pacific Island Network website (www1.nature.nps.gov/im/units/pacn).

Geographic Setting

Haleakala National Park (HALE) is located on east Maui and includes the summit of Haleakala volcano (10,023 feet) eastwards to sea level at Oheo and Kaapahu (see map below). HALE covers 30,183 acres and is divided into two districts. The Summit District includes the crater area, portions of its outer slopes, and the upper sections of the Kaupo and Koolau gaps. The wetter Kipahulu District includes Kipahulu Valley, Manawainui and Kaumakani planezes, upper Hana rain forest, Oheo /Puhilele coastal areas, and the 1999 Kaapahu addition. The majority of the park is designated as wilderness. Adjacent land owners include Haleakala Ranch, Kaupo Ranch, East Maui Irrigation Company (EMI) (Waikamoi Preserve managed by the Nature Conservancy of Hawaii), the State of Hawaii (Hanawï Natural Area Reserve and State Forest Reserves), and small private land owners. The majority of land use surrounding the park includes ranching on private lands and conservation on lands managed by members of the East Maui Watershed Partnership. Adjacent to the summit area is "Science City," a multi-institutional collection of observatories and antennas located on State land just southwest of the park. Maui's population (ca. 110,000 people) is concentrated near leeward coastal areas far from the park; fewer than 1,500 people live within 5 miles of the park.



Significant Natural and Cultural Resources

The Haleakala Section of Hawaii National Park was established for its scenic and geological features, primarily Haleakala Crater. Since becoming its own national park, HALE's biological resources have gained special attention within the scientific community. The park harbors a rich assemblage of native plant and animal communities with tremendous species diversity. Ecosystems include an alpine cinder desert, sub-alpine shrublands, sub-alpine grasslands, montane bogs and lakes, cloud and rain forests, mesic forest, and coastal strand. The Oheo / Puhilele and lower Kaapahu areas exhibit altered natural ecosystems targeted for restoration through select alien plant control, native, and Polynesian- introduced plantings. HALE is home to 26 federal threatened and endangered species (TES) with 15 TES candidates and 57 Species of Concern.

Areas of HALE are culturally and spiritually important to Hawaiians. These places have been traditionally used by Hawaiians for a wide range of activates from pre-contact (before 1779) times to the present day. Non-Hawaiian use has included the National Park Service, The Department of Defense, and ranching. HALE contains a wide variety of Hawaiian and non-Hawaiian tangible cultural resources. Although only a limited number of cultural resource studies have been conducted within HALE to date, it is known that the park contains numerous archeological resources, historic structures, museum objects, cultural landscapes, and ethnographic resources. Many of these cultural resources are located within two historic districts. The Crater Historic District is listed in the National Register of Historic Places (NRHP) and encompasses all of Haleakala Crater. The Kipahulu Historic District encompasses the lower portions of Kipahulu Valley, former pasture lands and the Oheo/ Puhilele coastal areas.

Resource Management Priorities

Resource management priorities identified in the park's 1995 General Management Plan are 1) Re-establish and perpetuate (as nearly as possible) the mosaic of ecosystems which would have evolved without interference of human technology. 2) Protect and restore native biota by controlling non-native plants and animals, particularly aggressive species which out-compete native forms. 3) Isolate and carefully restrict use of the upper Kipahulu Valley to ensure the perpetuation of nearly pristine native flora and fauna. 4) Maintaining the human altered Kipahulu coastal area in its present state with latitude for restoration of native plant communities (where appropriate). 5) Identify and protect cultural sites and remains, stabilize significant archeological structures and where appropriate, assist in the perpetuation and interpretation of traditional Hawaiian culture. 6) Encourage a comprehensive park research program for improvement of management and interpretation of Haleakala’s geologic, biotic, and cultural values.

NATURAL RESOURCES

Focal Ecosystems and Processes

Haleakala National Park includes several unique ecosystems that provide contrasting environmental conditions, rare and endangered species, and beautiful natural scenery.

- ***Rainforest/Cloud forest***: The rain and cloud forests of Haleakala National Park are among the richest and most ecologically intact in Hawaii. Nevertheless, rainforest habitat, especially mid-elevation forest is seriously threatened by alien species. Due to their inaccessibility the high elevation cloud forests of East Maui have been less impacted by human activities and alien species than lower elevation forests. In the upper Kipahulu Valley, more than 95% of native species are endemic. To protect this almost pristine native forest it has been closed to public entry. However, the impacts of climate change could be devastating for these extremely sensitive ecosystems.
- ***Bogs and Lakes***: Within the bog areas there are 15 endemic plant species that are largely confined to bog habitat. The bogs of Haleakala offer unique opportunities for the study of evolutionary patterns. Fencing has kept feral pigs (*Sus scrofa*) out of the bogs, saving this limited habitat from destruction. However climate change (reduced rainfall) could destroy this, unique ecosystem (Loope 1991, 1995). Two small high elevation lakes, Waianapanapa and Waieleele, are located within the bog habitat.
- ***Grasslands***: Unique *Descampsia* grasslands exist in the upper elevations of Haleakala.
- ***Mesic forest***: Large tracts of the mesic forest vegetation in Haleakala have been lost as a result of feral animals and human impacts such as fire, logging, and grazing. However, a few patches with rare mesic montane forest species remain in the Kaupo Gap area. The Kaapahu area contains mesic forest areas that were heavily impacted by logging and feral animals. Efforts are underway to protect and restore these forests by reducing the number of feral animals and re-vegetation efforts.
- ***Alpine/ Aeolian*** : The summit area's alpine climate zone is an extremely challenging environment due to the combination of intense radiation, large diurnal temperature variations and low rainfall combined with extremely porous soils. Few plants and animals have adapted to these harsh conditions. Haleakala Silversword and its relatives along with numerous endemic invertebrate species such as the Aeolian wolf spider have adapted to this harsh environment.
- ***Caves (Lava tubes)****:* Several caves of varying sizes are located within Haleakala National Park. Besides their significance as cultural/archaeological sites they provide ecological niches that have allowed the evolution of specialized and often rare arthropods (Medieros et. al. 1989). Visitor impacts and alien species are threats to cave resources.
- ***Scenic Values:*** The scenic beauty of Haleakala National Park encompasses lush rainforest, waterfalls, streams, and the beauty of a seemingly barren volcanic landscape. From the summit of Haleakala one can see the Hawaiian Island chain laid out before them. A few of the most popular scenic attractions are listed below.
    - Haleakala Crater vistas
    - Haleakala Crater wilderness areas

- Makahiku Falls
- Palikea Stream
- Pools of Oheo

***Threatened and Endangered Species*:** HALE is home to 26 federal threatened and endangered species (TES) with 15 TES candidates and 57 Species of Concern. Over 90% of the native biota found in Haleakala National Park is endemic to the Hawaiian Islands; nearly 50% is endemic to Maui. Human activities, in particular introduction of alien plants and animals has led to the extinction or severe decline of a number of native species.

- ***Haleakala Silversword**:* Silverswords (*Argyroxiphium* sp.) are one of the few plant species thriving in the inhospitable environment of the western part of Haleakala Crater (6,500 -10,000 feet). However alien western yellowjackets (*Vespula pensylvanica*) as well as Argentine ants (*Linepithema humile*) prey upon native insects including the primary pollinator for Silverswords (Krushelnycky 2004, Gambino 1992).
- ***Maui Greensword***: The Greensword (*Argyroxiphium grayanum*) is confined to the small but unique bog habitat in the upper Hana rain forest (Gagne 1982). Destruction of bog habitat by pigs severely reduced greenswords and other rare endemic plants, populations have recovered following fencing efforts.
- ***Argyroxiphium virescens***: A silversword relative, this plant once thrived just above dense rainforest at 6,000 – 7,000 ft elevation (Carr 1998). Habitat destruction (replacement of native forest with eucalyptus species), browsing of feral goats (*Capra hircus*) and cattle (*Bos taurus*) grazing led to the extirpation of this species from the park. Plans are underway to reintroduce this species from surviving population.
- ***Red-flowered tree geranium***: *Geranium arboretum* is endemic to Haleakala at 6,000 -7,000 feet elevation. Populations have been reduced due to browsing by cattle and goats. In Haleakala National Park scattered individuals can be found in the Summit District (Funk 1988).
- ***Haleakala sandalwood***: *Santalum haleakalae* grows in the Summit District. Fruits are eaten by rats and mice (Cole et. al. 2000). However, its ability to reproduce vegetatively and new horticulture techniques may help the survival of this rare species.
- ***Hawaiian mints, Hawaiian Orchids, Hawaiian Lobelias***: Fencing and removal of feral pigs and plants has resulted in a dramatic recovery of Hawaiian mints, orchids, and lobelias in the upper portion of Kipahulu valley. However, in unfenced areas endemics in these plant groups have not recovered (Stone et al. 1992)
- ***Nene (Hawaiian Goose)*** Following extirpation from Maui in 1890 the Nene (*Banta sandwicensis*) was reintroduced to Haleakala National Park in 1962 from captive bird stock. However they are threatened by feral cats, mongoose, and the occasional feral dog that eat the eggs and young birds.
- ***Uau (Hawaiian Petrel)**:* Uau (*Pterodroma phaeopygia sandwichensis*) once nested throughout the park from coastal areas to the top of the mountain. Uau are

the only seabirds listed as "endangered" in Hawaii. Haleakala is home to the world's largest protected colony of Uau however habitat destruction and depredation of young birds and eggs has contributed to declining populations of petrels (Hodges 1994a).

- ***Hawaiian Honeycreepers***: Five of the nine native Hawaiian honeycreepers found in east Maui are listed as "endangered." The Maui Nukupuu (*Hemignathus lucidus affinis*), and Maui Akepa (*Loxops coccineus ochraceus*) are listed as endangered and may be extinct. The Akohekohe or Crested Honeycreeper (*Palmeria dolei)* and Maui Parrotbill (*Pseudonestor xanthophrys*) are endangered. The critically endangered Po'ouli (*Melamprosops phaeosoma*), with only 3 known individuals surviving is not present in the park but is found the adjacent Hanawï Natural Area Reserve where protection and recovery efforts are being attempted (Casey and Jacobi 1972). The more common honeycreepers include the Iiwi (*Vestiaria coccinea*), Maui Alauahio or Maui Creeper (*Paroreomyza montana*), Apapane (*Himatone sanguinea*), and Amakihi *(Hemignathus virens*). Habitat destruction, disease, and introduced predators are the main causes for the decline of their populations, and the extinction of other species (Scott et. al. 1996).
- ***Invertebrates***: Prior to human contact, 99% of the Hawaiian insects were endemic to the islands (Howarth 1992). Many of the native insects are important pollinators and the decline or extirpation of these species initiates a chain-reaction of further declines of native plant and animal populations. Habitat destruction and introduced predator species (rats, mice, birds and insects) are the most severe threats to endemic insects (Gambino 1982, Krushelnycky 2004). Following is a list of the rarest invertebrate groups. For some of the species in these groups their status is unknown and they may be extinct.

    - Hawaiian katydids and crickets
    - Haleakala flightless lacewings
    - Hawaiian ground beetles
    - Hawaiian long horned beetles
    - Haleakala weevil
    - Hawaiian Noctuid moth
    - Hawaiian carnivorous inchworm
    - Haleakala flightless moth
    - Hawaiian butterflies
    - Hawaiian yellow-faced bees
    - Happy face spider

- ***Fish:*** One rare endemic fish, the Oopu (*Lentipes concolor)* is found in the Pipiwai stream, Palikea stream and Oheo Gulch
- ***The Hawaiian Monk Seal or ilioholoikauaua*** (*Monachus schauinslandi*) occasionally visits the waters and rocky shorelines of Oheo.

- ***The Hawaiian Hoary bat or opeapea*** (*Lisiurus cinereus semotus*) has been observed at all elevations and in varying habitats throughout the park but little is known about its distribution and abundance (Duvall and Gassman-Duvall 1991).

Threats & Stressors

Introduced plants and animals as well as natural phenomena pose the greatest threats to Haleakala's Natural Resources. Some examples include:

- Uncontrolled or insufficient control of established alien plants and animals in the park that continue to spread
- Invasions of alien plants and animals (brown tree snake, Melastomes, grasses)
- Depredations by alien mammal, invertebrate, and potential reptilian and amphibian predators on native species
- Impacts of avian diseases on endemic avifauna
- Loss of key species such as host plants, plant dispersers and pollinators
- Potential visitor impacts in aquatic, sensitive, or wilderness areas
- Developing park infrastructure
- Increasing park visitation
- Further loss of biodiversity
- Renewed volcanic activity
- Wildfires
- Climate change

Water Quality Designations

Hawaii's surface and marine waters are classified according to their use by the Hawaii Department of Health under Hawaii Administrative Rules, Title 11, Ch. 54, 2000. The mean high tide zone is the official boundary on the HALE coast. Streams, springs, and coastal waters in the Kipahulu district are undiverted and pristine. Sub-alpine lakes are considered unique resources. There are no impaired waters in the park. Marine waters are classified as AA (in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions.

CULTURAL ISSUES

- Collection of plants for traditional use
- Harvesting of endemic freshwater species for human consumption
- Traditional farming practices within the park
- Impacts to cultural sites by visitors
- Impacts to cultural sites by vegetation
- Cataloging and management of natural history museum items

MANAGEMENT ISSUES

Park Management

Natural resource management issues at Haleakala emphasize identification and mitigation of threats in order to preserve and protect park resources.

Park management documents (General Management Plan, Resource Management Plan, etc.) are available on-line at the NPS intranet site (http://www1.nrintra.nps.gov/im/units/pacn/parks/mgmt_docs.htm). This website is available only from NPS computer networks. Inquiries about public access should be directed to the park.

Invasive species: Some of the strategies used by the resource management division to control and eradicate invasive species at Haleakala have proven effective in the protection and recovery of the native ecosystems (Loope and Medieros 1994). Continued efforts by NPS and cooperators remain an integral component of sustaining a native ecosystem.

Alien Plants: Alien plant invasions are the most significant management problem at Haleakala . Although several species are aggressively spreading throughout the park, *Miconia calavensis* is the most incipient weed currently threatening the park. *Miconia* has the ability to generate dense stands blocking out other plants thereby invading the native ecosystem. It also has a shallow root system and when located on steep slopes, contributes to erosion and landslides. Control is possible with the uprooting of smaller plants or the cutting down of larger plants and treating the stumps with herbicide (Chimera et. al. 2001).

Alien Mammals: Construction of boundary fences in combination with aggressive feral animal removal strategies has effectively reduced feral pigs and goats in forest areas. Research was used to determine the appropriate pig removal method. On-the-ground control methods are the most successful techniques for the removal of ungulates in fenced areas (Diong 1982).

The rapidly increasing Axis deer population on Maui is another significant threat to the park. While the majority of the population is outside park boundaries, Axis deer are occasionally leaping park fences and are spotted within park boundaries. These animals bring with them adverse effects of grazing to recovering ecosystems (Waring 1996).

Mongooses, feral cats, rats and occasionally feral dogs are extremely threatening to endangered ground nesting 'Uau (Hawaiian - Petrel) and Nene (Hawaiian Goose) populations. Trapping and toxic baits are labor-intensive but prove effective means of controlling these predators. Rats and mice prey on native insects and seeds of native plants, threatening plant reproduction (Cole et. al. 2000). Additional funding is necessary to fully implement their predator control program in all areas of the park.

***Alien Invertebrates*:** Argentine ants and Western Yellow jacket wasps threaten the existence of endemic invertebrates (Gambino et. al. 1987, Cole et al. 1992). Lures and toxic baiting are current control methods for ants and wasps (Krushelnycky and Reimer 1996, Loope 1987). Research to control these ants is ongoing with some assistance from the Clorox Company(Krushelnycky 2004).

Visitor impacts: Visitor impacts to natural resources include cinder compaction at higher elevations, lack of waste removal (creating food sources for rodents and ants), livestock use in backcountry areas, and illegal use of fire rings at campground areas. Although some strategies have been implemented a great need exists for funding education and interpretive programs that address these concerns.

Soundscape: Despite an informal agreement with helicopter tour companies to discontinue flights over the Crater for scenic viewing noise is audible and continues to remain a problem threatening sound quality of the native ecosystem.

Native Plants: Native plant restoration projects within Haleakala Crater have been successful in restoring p*ü*kiawe *(Styphelia sp*.), aalii (*Dodonaea sp*.), ohelo (*Vaccinium sp*.), and u*lei* (*Osteomeles anthyllidifolia*) from past goat browsing. In contrast, recovery of the *mamane* forest on the North Slope of the Crater has not occurred because of the absence of native bird populations which are needed to distribute seeds. Some recovery efforts at lower elevations in rainforests areas have also not been effective due to continued damage from feral pigs and the invasions of alien weeds.

INVENTORIES

Existing Inventories in Park

Vegetation: As part of the Kipahulu Expedition in 1967 Hoe inventoried the Mosses of upper Kipahulu valley and Lameroux inventoried the vascular plants the results are published in The Kipahulu Valley Report. These studies describe numerous endemic and not previously described species. http://www.botany.hawaii.edu/faculty/duffy/SPECI/PDF/1967b.pdf.

Lameroux and Stemmerman revisited the 1967 Kipahulu valley inventory sites in 1975 and added 2 new plants to the list. The results were published in PCSU Technical report 11. http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/11.pdf.

A Bryophyte inventory of sites below 2000 feet in Kipahulu Valley was conducted by William J. Hoe (1980) and published as a Resource Basic Inventory. Canfield and Stemmerman (1980) inventoried vascular plants and Hoe inventoried Bryophytes below 2000 feet in Kipahulu Valley and as part of the 1980 Resources Basic Inventory published as PCSU Technical report 24 http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/24.pdf.

Yoshinaga (1980) documented 47 weed species in Kipahulu Valley in an inventory of weeds published as PCSU Technical report 33. http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/33.pdf.

Smith et al. (1985) Made vegetation maps for Kipahulu Valley below 700 meters. These maps and recommendations for management were published as PCSU Technical Report 53. http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/53.pdf.

Vascular plants in the crater were inventoried as part of The Resources Basic Inventory published in 1975 (Berger et. al.) The inventory was confined to the crater and immediate surrounding area. The results were published as PCSU Technical Report 9. http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/9.pdf. An inventory of Ferns and Fern Allies in was published in 1981 as PCSU technical report 39 by Heart, Higashino and Smith. This list detailed Forty-nine species of ferns and fern allies were found in the Crater District of Haleakala National Park during the three-year Resources Basic Inventory program from 1975 to 1977. http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/39.pdf.

In 1979 Hoe published an inventory of Haleakala National park mosses. Sites were inventoried over the course of three summers previous to publication. 128 moss species and varieties were collected and identified. The results were published as PCSU Technical report 25 available online at http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/25.pdf.

In 1979 an inventory of vascular plants in Puauulu stream was published as a PCSU Technical Report 27 (Higashino and Croft 1979). The vegetation inventory was part of a larger study that included aquatic fauna quality. Technical report 27 is available online at http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/27.pdf.

Higashino and Mizuno inventoried the Manawainui area as part of the Manawainui research project in 1976. A vascular plant checklist and vegetation map was produced for the Manawainui area as part of the Manawainui report.

Inventories of bog plants were first done by C.N. Forbes in 1919. St. John and Mitchell inventoried the bogs in 1945.

Mitchell (1945) created the first checklist of plants for the crater district of HALE. Higashino et al. (1988) published a checklist of 500 vascular plants found in Kipahulu Valley. Vegetation maps were compiled by Jim Jacobi in 1989 and published as PCSU technical report 68. This is online at http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/68.pdf.

A compilation of past inventories and a comprehensive checklist of Flowering plants and gymnosperms of Haleakala National Park was published in 1998 by Medieros et al. as PCSU Technical report 120. This valuable resource is available online at

http://www.botany.hawaii.edu/faculty/duffy/techrep.htm. Plant lists are updated by park staff as new plants are documented in the park.

On going vegetation inventories include a road side inventory of weeds within the park front country and a vegetation inventory of the Kaapahu land division.

Terrestrial Vertebrates: Forest bird inventories of Kipahulu were conduced in 1967 as part of interagency Kipahulu expedition. During this survey the Maui Nukupuu previously thought to be extinct was rediscovered (Banko 1967). Kipahulu report is available online at http://www.botany.hawaii.edu/faculty/duffy/SPECI/PDF/1967b.pdf. Conanat and Stemmerman inventoried avifauna in Kipahulu Valley in 1980. A 1981 Resources Basic Bird Inventory Below 2000 feet in Kipahulu included a bird inventory published by Lani Stemmerman. http://www.botany.hawaii.edu/faculty/duffy/SPECI/PDF/1980.pdf Forest bird populations in Kipahulu Valley are inventoried each year by parks staff and periodically by the US Fish and Wildlife Service using Variable Circular Plot (VCP) survey methods.

Berger conducted a bird inventory of the crater in 1975. The results of this are published in a Resource Basic Inventory PCSU Technical Report 9 available online at http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/9.pdf

In 1976 and forest bird inventory of Manawainui was conducted by Stemmerman. Mammals and freshwater vertebrates were also inventoried in Manawainui as part of the Manawainui research project (Gon 1976).

A 1979 Freshwater vertebrate inventory of Puaulu stream was published as PCSU Technical report 27 (Kinzie 1979). http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/27.pdf

A Resource basic inventory of vertebrates except birds was published by smith in 1980. This is available online at http://www.botany.hawaii.edu/faculty/duffy/SPECI/PDF/1980.pdf

Feral pig numbers in Kipahulu were inventoried using a combination of counts from animal removal within fenced units and by analyzing the freshness of ungulate signs on established transects (Anderson 1994).

Animal inventories of Kaapahu are underway to understand the number and impacts of introduced animals on the area.

Invertebrates: The 1967 Kipahulu Valley expedition included an insect inventory by Wilson. He discovered species not previously discovered and endemic to the valley. The report is available online at http://www.botany.hawaii.edu/faculty/duffy/SPECI/PDF/1967b.pdf

In 1975 a Resource based inventory of the Crater and was conducted and an invertebrate inventory was produced (Berger 1975). Several endemic species were noted. The RBI is available online at http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/9.pdf

The 1976 Manawainui report includes an insect inventory by Richard Villegas.

An entomological survey of Puaulu stream was conducted in 1979 by Hardy and published as tech report 27. http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/27.pdf

Inventories of insects and myriapods (Gange 1980), the arachnid fauna (Gon 1980), and the Land mollusks (Severns 1980) in Kipahulu Valley below 2000 feet were published in the Resources Basic Inventory of Kipahulu Valley below 2000 feet. The RBI is online at http://www.botany.hawaii.edu/faculty/duffy/SPECI/PDF/1980.pdf

In 1980 Beardsley conducted a comprehensive inventory of insects in the Crater District and published his results as PCSU technical report 31. This is available online at http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/31.pdf

Surveys of argentine ant invasions were conducted in by Fellers 1981. The results were published as Technical report and are available online at http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/40.pdf. These inventories lead to an ant monitoring program to asses the impacts of these invasive ants on native invertebrates. .

Current inventories of crater district invertebrates are ongoing in conjunction with argentine ant studies.

Native Freshwater Communities: Inventories of stream fauna on the east side of the park were conducted on several occasions. Lower Palikea and Pipiwai stream and Puaulu streams were surveyed by Kinzie 1977 the data is published in PCSU Tech report 17 http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/17.pdf. An inventory of Puaulu stream was published in 1979 as PCSU Technical report 27 (Kinzie 1979). http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/27.pdf. The Alelele stream steam was surveyed by Paul O'Connor in 1995. Native and non-native species Hihiwai (*Neritina granosa*), Oopu (*Lentipes concolor*), Tahitian prawns (*Macrobrachium lar*), vegetation, and various invertebrates have been inventoried in these streams.

Priorities for New Inventories in Park

***Vegetation*:** Recent **e**xtensive Inventories of vegetation in the Manawainui area are lacking.

Invertebrates: Cave resources have yet to be inventoried in the Haleakala National Park. Cave resources include important cultural and biological elements that are unique to HALE.

***Vertebrates*:** Like all of Hawaii's National Parks, HALE's herpetological information is lacking. Research is needed to know the distribution and taxa of amphibians and reptiles in park lands and surrounding areas, so that their impacts on park resources can be ascertained and long tem monitoring can be conducted.

Freshwater Communities: The streams of the Kaapahu area are thought to be high quality freshwater systems. Intensive inventories of streams in the Kaapahu area need to be completed.

Buffer Zone Inventories

Vegetation: The Mosses and Vascular Plants of Waihoi Valley were inventoried by Harrison in 1972. (Kjargaard 1972). In 1971 Hendrickson published "Vascular flora of the northeast outer slopes of Haleakala Crater, East Maui, Hawaii". This includes the Hana and Koolau forest reserves. The south west slope of Haleakala was inventoried by Medieros and published as PCSU Technical Report 59. http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/59.pdf

Vertebrates: A preliminary inventory of mammal, forest birds (Gon 1972) , and aquatic fauna (Ibara 1972) were conducted in Waihoi Valley, a large valley adjacent to Kipahulu .

Invertebrates: Harrison (1972) Inventoried the land snails of Waihoi Valley. The results are published in the Waihoi Valley Report.

MONITORING

Existing Monitoring in Park

Vegetation : Vegetation monitoring includes annual surveys of the Haleakala silversword (*Argyroxiphium sanwicensis*) at fixed locations which began in 1982 (Kobayashi 1992) . Monitoring of recent Koa (*Acacia koa*) defoliation in the Kipahulu valley occur to determine the extent of defoliation and the rate of recovery in these areas. Out planted native pants are monitored regularly to assay growth and plant health. Rare plants are monitored to examine growth, phenology and recruitment.

A Bog monitoring began in 1973 (Loope 1988) and was repeated in 1977 (Yoshinaga). After that point feral pig damage occurred in the bogs. Some bogs were fenced and monitoring took place annually from 1981- 1984 (Loope 1991). Vegetation communities in the bogs were monitored for change in 1982, 1984, 1986, and 1988 (Medieros 1991) . The reports and results o f these monitoring episodes were published as PCSU Technical reports 76-78 and are available online at http://www.botany.hawaii.edu/faculty/duffy/techrep.htm. Bog monitoring was repeated in 2001.

Jacobi (1981) Monitored the changes in the Kapawiali grassland after disturbance by feral goats. This information was published as PCSU Technical Report 41, online at http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/41.pdf

Yoshinaga 1980 monitored the changes of vegetation when areas were fenced off and feral pigs were removed. The results of this monitoring lead to fencing off of Kipahulu valley and extensive ungulate control.

Monitoring of alien specific alien plants has involved the monitoring of Australian tree fern and extensive monitoring of the phenology and spread of alien plants (Medieros 1992).

An inventory of weed and their distribution in Kipahulu Valley above 3000 feet was conducted and published as part of a larger work on alien plants in Hawaiian natural areas (Anderson 1992).

Alien plant control teams monitor what plants they control as well as the location, size, quantity and methods they use to control exotic plants.

Tree line monitoring is underway to determine the effects of climate change on ecotones.

Vertebrate: Vertebrate monitoring projects at HALE focus on native bird species. Monitoring of Nene populations include daily sightings for individual Nene, annual counts, and nest searches. Monitoring of Uau includes monthly nest monitoring of known burrows for ‘Uau, nest searches, and annual mark-recapture of individuals. Monitoring of forest birds in the upper portion of Kipahulu Valley occurs annually using the Variable Circular Plot (VCP) method. Predator control as part of the Nene/Petrel protection program provides trapline catch data for rats, cats, and mongooses.

Base line avian disease monitoring was conducted in Kipahulu Valley and Kaapahu during the fall and winter of 2003. The intent of the study was to asses the extent of avian pox and malaria in these areas and identify the sources of the mosquito vectors.

Diong (1982) monitored feral pigs in Kipahulu valley and published his results as comprehensive PHD thesis. Data from this thesis was used to implement current management strategies in Kipahulu Valley.

Previous extensive monitoring of ungulates by Alvin Yoshinaga in Kipahulu valley resulted in fencing of entire sections of Kipahulu and other areas of the park. Due to management actions ungulate presence in fenced areas is very low to nonexistent. Current monitoring of ungulates occurs when staff checks the park's fences for feral animal control. Ungulate signs are recorded and action is taken to remove the animals.

Andromodous fishes were monitored in Oheo Gulch and Puaulu stream. The results of this project were published by Marc Hodges (1994) in PCSU technical report 93 online at http://www.botany.hawaii.edu/faculty/duffy/TECHR/PDF/93.pdf

Invertebrate: Invertebrate monitoring targets two alien species the argentine ant and the western yellowjacket. Monitoring the borders of argentine ant populations began in 1998 and occurs, coupled with annual control. The goal is to document and contain the spread of the ant population. Monitoring of western yellow jacket activity throughout the Crater District takes place to study the spread of yellow jackets and the effectiveness of control measures.

Freshwater Communities: USGS Water Resource Division has stream gagging data from Kipahulu valley 1927-1983. In 1983, the gage was moved to a lover site on Palikea stream. Future plans include stream flow data from this gage to be available on a real-time basis.

Visitor impacts: Information on the number of park visitors is collected for both the crater district and Kipahulu district. Information is collected on total vehicles, passenger number, recreational visitors, and use of back country and front country camping facilities. This information is used to monitor monthly and annual fluxes in park visitation. Visitor comments are also collected via comment cards at the visitor center.

Air Quality: Microclimate data is collected at several University of Hawaii sponsored weather stations at in the park to document baseline conditions. Haleakala has been part of the NPS air quality monitoring network since 1987. Particulate and gaseous monitoring equipment for the NPS air quality monitoring program is located at the Olinda Endangered Species Propagation Facility, 3.8 miles northwest of the park at approximately 1,100m elevation. Visibility monitoring began in 1987 with 35mm camera documentation. Improve particulate monitoring beginning in 1991 – the present. From 1991-1995, ozone, RH precipitation, solar radiation, ambient temperature, wind speed and direction were monitored as part of the gaseous pollutant network.

Climate Change**:** 11 weather stations established between1988- 1992 located at windward & leeward sites between 960 m and 2590 m . 9 of the stations are within the park boundries. These stations collect meteriological data to study climate change. Information is available at http://webdata.soc.hawaii.edu/climate/HaleNet/Index.htm.

Priorities for New Monitoring in Park

Vegetation: Vegetation monitoring priorities include fire fuel monitoring in dry land forest, continued weed monitoring, continued silversword, monitoring and setting up set protocols for rare and endangered plant monitoring.

Terrestrial Vertebrate: No current program exists for monitoring of the Hawaiian Monk Seal or Hawaiian Hoary Bat. A native mammal monitoring program would enable managers to better understand the necessity for management to involve decisions to be made based on the status of these species.

Buffer Zone Monitoring

Vegetation: Ungulate and weed transects are monitored in the adjacent Hanawi Natural Area reserve and The Nature Conservancy's Waikamoi Preserve. The spread and control of Miconia is currently monitored by a consortium of federal, state, and private management areas (Conanat 1997).

Terrestrial Vertebrate: The State of Hawaii together with the US Fish and Wildlife Service monitors native forest bird and introduced predator populations in Hanawï.

Native Freshwater Communities: USGS WRD research is ongoing in streams along the windward side of East Maui. Biota and water quality is examined in diverted and free flowing streams.

Air Quality: Particulate and gaseous monitoring equipment for the NPS air quality monitoring program is located at the Olinda Endangered Species Propagation Facility, 3.8 miles northwest of the park at approximately 1,100m elevation.

CONCLUSIONS

Haleakala National Park is contains unique natural and cultural resources. The park contains diverse unique environments and endemic species. Isolated and pristine ecosystems allow researchers to discover plants and animals that are new to science. These unique resources are threatened the introduction of plants and animal foreign to the Hawaiian Islands. Fires destroy unique dry land plants, goats turn ridges into barren wastelands, pigs dig up rare plants, foreign plants such as strawberry guava and Kahili Ginger take over fragile native rain forests, and the threat of Miconia infestation grows closer to the park boundary.Many of the plants and animals once found in these areas have gone extinct in historical times and the park its self contains a variety of rare and endangered biota. To ensure the preservation of these unique resources managers must continue to monitor these elements and implement aggressive actions such as fencing, ungulate control, alien plant control, and revegetation to ensure that these unique species and ecological communities will exist in perpetuity.

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